



# LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

**Volume 5 | Technical Appendices**

CFA13 | Calvert, Steeple Claydon, Twyford and Chetwode  
**Data appendix (AG-001-013)**  
Agriculture, forestry and soils

November 2013

# **LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT**

**Volume 5 | Technical Appendices**

CFA13 | Calvert, Steeple Claydon, Twyford and Chetwode

**Data appendix (AG-001-013)**

Agriculture, forestry and soils

November 2013

ES 3.5.2.13.1



# Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

A report prepared for High Speed Two (HS2) Limited.

High Speed Two (HS2) Limited,  
Eland House,  
Bressenden Place,  
London SW1E 5DU

Details of how to obtain further copies are available from HS2 Ltd.

Telephone: 020 7944 4908

General email enquiries: [HS2enquiries@hs2.org.uk](mailto:HS2enquiries@hs2.org.uk)

Website: [www.hs2.org.uk](http://www.hs2.org.uk)

High Speed Two (HS2) Limited has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the HS2 website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact High Speed Two (HS2) Limited.



Printed in Great Britain on paper  
containing at least 75% recycled fibre.

# Contents

<b>Contents</b>	i
<b>1 Introduction</b>	1
<b>2 Soils and Agricultural Land Classification surveys</b>	2
2.1 Background	2
2.2 Soils and land resources	3
2.3 Soils and land use interactions	7
<b>3 Forestry</b>	15
<b>4 Assessment of effects on holdings</b>	16
<b>5 References</b>	22

## List of figures

Figure 1: Evesham 2 (411b), Ashley (572q), Wickham 2 (711f), Beccles 3 (711t), Denchworth (712b), Ragdale (712g) and Fladbury 1 (813b) soils in a landscape context	5
Figure 2: Methodology for calculating the severity of a droughtiness limitation to Agricultural Land Classification grading	9
Figure 3: Agricultural Land Classification grade according to soil wetness	13

## List of tables

Table 1: Bedrock and soil forming materials	3
Table 2: Dominant soil series descriptions	5
Table 3: Interpolated agro-climatic data for Barton Grounds Farm	10
Table 4: Typical soil profile description at Barton Grounds Farm	10
Table 5: Interpolated agro-climatic data	11
Table 6: Area of woodland within the study area and construction boundary	15
Table 7: Summary of assessment of effect on holdings	16

# 1 Introduction

- 1.1.1 The agriculture, forestry and soils appendices for the Calvert, Twyford and Chetwode community forum area (CFA13) comprise:
- soils and Agricultural Land Classification (ALC) surveys (Section 2);
  - forestry (Section 3); and
  - farm impact assessment summaries (Section 4).
- 1.1.2 Maps referred to throughout the agriculture, forestry and soils appendix are contained in the Volume 5, Agriculture, Forestry and Soils Map Book.

## 2 Soils and Agricultural Land Classification Surveys

### 2.1 Background

- 2.1.1 The agricultural baseline data has been derived from both desk study and site investigation. Information gathered by the desk study has related primarily to the identification of soil resources in the study area, the associated physical characteristics of geology, topography and climate which underpin the assessment of agricultural land quality, and the disposition of land uses. The main sources of information have included:
- National Soil Map<sup>1</sup>;
  - Soils and Their Use in South East England<sup>2</sup>;
  - solid and superficial deposits from the Geology of Britain viewer<sup>3</sup>;
  - gridpoint meteorological data for Agricultural Land Classification of England and Wales<sup>4</sup>;
  - Provisional Agricultural Land Classification of England and Wales (1:250,000)<sup>5</sup>;
  - Likelihood of Best and Most Versatile Agricultural Land (1:250,000)<sup>6</sup>;
  - agri-environment schemes<sup>7</sup>;
  - computer-aided light detection and ranging (LiDAR) elevation data for determination of gradient;
  - aerial photography; and
  - site-specific soil and ALC surveys.
- 2.1.2 Where the collection of agricultural site information has enabled a review/refinement of published information, this was undertaken in accordance with the methodology prescribed by the Ministry of Agriculture, Fisheries and Food (MAFF)<sup>8</sup>.
- 2.1.3 Engagement with landowners and tenants between May 2012 and June 2013 has established the nature and extent of agricultural, forestry and related rural enterprises. Information obtained from farm impact assessment interview surveys has

<sup>1</sup> Cranfield University (2001), *The National Soil Map of England and Wales* 1:250,000 scale.

<sup>2</sup> Soil Survey of England and Wales (1984), *Soils and Their Use in South East England*.

<sup>3</sup> British Geological Survey. <http://bgs.ac.uk/geologyofbritain/home/html>: Accessed on 18 March 2013

<sup>4</sup> Meteorological Office (1989), *Gridpoint Meteorological data for Agricultural Land Classification of England and Wales and other Climatological Investigations*.

<sup>5</sup> Ministry of Agriculture, Fisheries and Food (MAFF) (1983), *Agricultural Land Classification of England and Wales* (1:250,000).

<sup>6</sup> Department for Environment, Food and Rural Affairs (Defra) (2005), *Likelihood of Best and Most Versatile Agricultural Land* (1:250,000).

<sup>7</sup> Multi-Agency Geographical Information for the Countryside (MAGIC) available on line @ <http://www.magic.gov.uk/>, accessed August 2013.

<sup>8</sup> MAFF (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

been taken as a factual representation of local agricultural and forestry interests and has not been subject to further evaluation.

## 2.2 Soils and land resources

- 2.2.1 The location and extent of soil types displaying different characteristics and of agricultural land in the different ALC grades are influenced by topography, drainage, geology, and soil parent material which are described in turn below. This section then provides a description and distribution of the main soil types encountered along the study corridor. The main soil and land use interactions are then evaluated and include agricultural land quality and other key soil interactions along the route within this study area.

### Topography and drainage

- 2.2.2 The main topographical features within the study area include a series of rolling hills to the north-east which vary in altitude from around 80m to 105m above Ordnance Datum (AOD) and are characterised by moderate gradients. The main arterial drainage is provided by the Padbury Brook which crosses the Proposed Scheme a number of times, and the numerous drainage ditches which are found throughout the area. At the southern end of the study are the Grebe Lakes at Calvert.

### Geology and soil parent materials

- 2.2.3 The principal underlying geology between Calvert and the north west of Twyford is that of the Peterborough Member of the Oxford Clay Formation and typically consists of brownish grey organic-rich mudstone. Towards Twyford superficial river terrace deposits of sand and gravel are also mapped by the British Geological Survey (BGS). As land begins to rise up from Twyford the Kellaways Formation is mapped and continues toward Newton Purcell. This consists of silty or sandy mudstone with beds of calcareous siltstone and sandstone. Around Newton Purcell superficial deposits of glacial diamicton overlie the bedrock geology.
- 2.2.4 A list of geological strata occurring within the study area is provided in age order in Table 1 and shown on Map WR-02-013 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

Table 1: Bedrock and soil forming materials

Formation	Composition/soil parent material
Kellaways	Mudstone with beds of calcareous siltstone and sandstone
Oxford Clay	Silicate mudstone with sporadic beds of limestone nodules
Superficial deposits	
River terrace	Sequences of sands and gravels with flint, quartz and quartzite
Diamicton	Unsorted clay and silty clay, commonly pebbly and sandy, interbedded with sand and gravel-rich lenses and rare peat

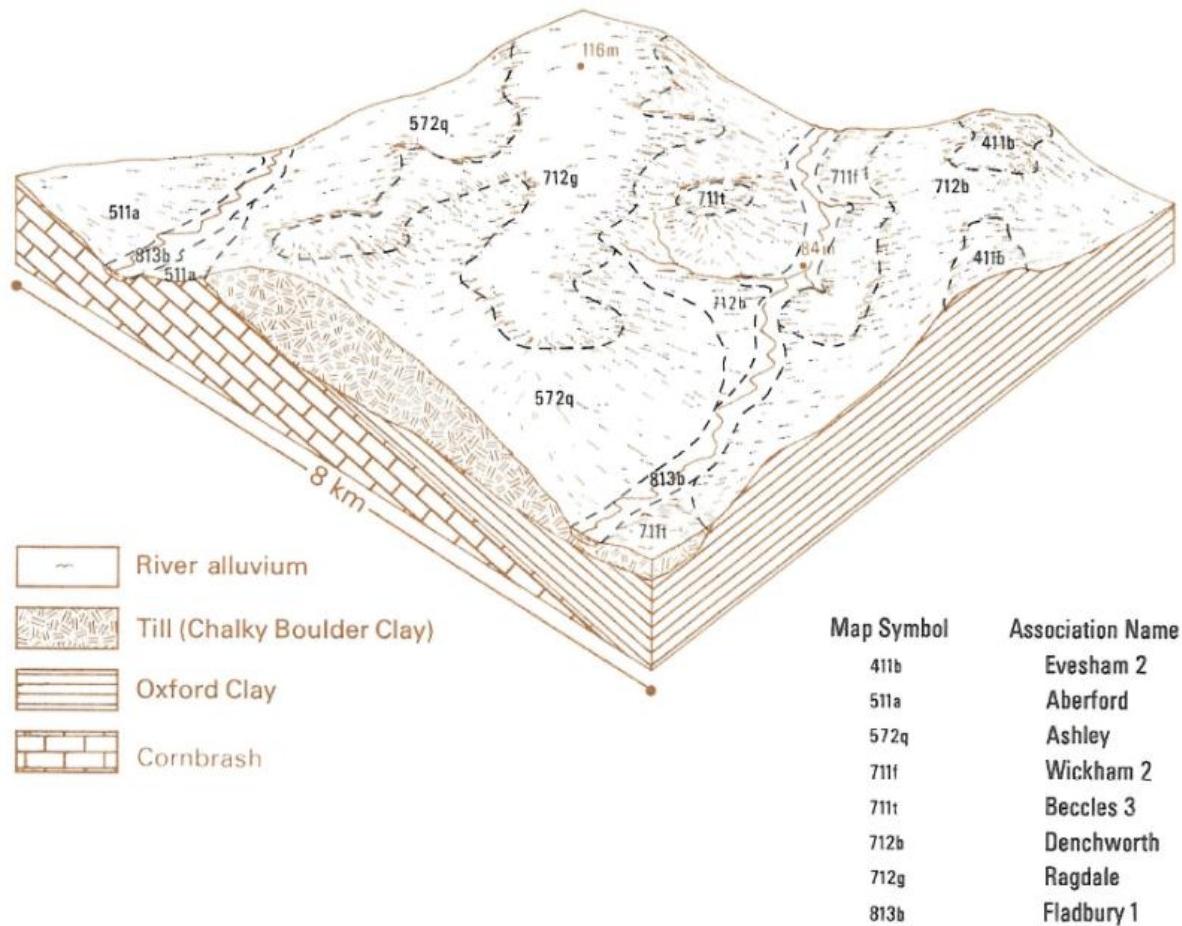
## Description and distribution of soil types

- 2.2.5 The characteristics of the soils are described by the Soil Survey of England and Wales<sup>2</sup> and shown on the National Soil Map<sup>1</sup>. The soils are grouped into associations of a range of soil types (soil series) showing similar characteristics.
- 2.2.6 The National Soil Map shows the section to be dominated by soils described as slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Two additional types are also mapped: the first is a slightly acid, loamy and clayey soil with impeded drainage and the second is the loamy and clayey floodplain soil with high groundwater.
- 2.2.7 The soils are variable according to the topography and geology. Across most of the alignment of the Proposed Scheme the Denchworth association is mapped which is typically stoneless or slightly stony, wet, clay, clay loam or silty clay loam in texture. These soils are poorly drained with soils being waterlogged for prolonged periods throughout the year and are most commonly assessed as being of Wetness Class<sup>9</sup> (WC) IV.
- 2.2.8 The Evesham 2 and Wickham 2 associations are also present in the south of the section with Beccles 3 in the central eastern section. These soils have fine loamy, sandy clay loam or clay topsoils and overlie clay. Evesham 2 and Beccles 3 association soils occupy hill slopes and hill tops and are moderately well drained and of WC II or III. Wickham 2 soils are slightly less well drained and of WC III or IV and occur on the floodplains.
- 2.2.9 Associated with the streams and tributaries joining the Padbury Brook are soils of the Fladbury 1 association. These soils are clay alluvial soils and are poorly or very poorly drained of WC IV.
- 2.2.10 The Ashley, Bishampton 2 and Ragdale soil associations are present in the north of the section where they overlie bedrock of the Kellaways and Cornbrash Formations. Ashley and Ragdale soils comprise fine loamy, clay loam and clay textures of WC II to III. Ashley soils are better draining with soils typically of WC III to IV.
- 2.2.11 The Bishampton 2 soils occur in the northern extremity of the study area and have a sandy loam or sandy clay loam texture and are stoneless or slightly stony. They are typically of WC II or III.
- 2.2.12 Figure 1 shows how topography, geology and many of the soil types described above relate in a landscape context.

---

<sup>9</sup> The Wetness Class (WC) of a soil is classified according to the depth and duration of waterlogging in the soil profile and has six bands.

Figure 1: Evesham 2 (411b), Ashley (572q), Wickham 2 (711f), Beccles 3 (711t), Denchworth (712b), Ragdale (712g) and Fladbury 1 (813b) soils in a landscape context<sup>10</sup>



2.2.13 Where data are available describing the predominant soil series of each association present within the Calvert, Twyford and Chetwode study area, these have been included in Table 2. References to soil colours have been derived from a standard Munsell Soil Colour Chart<sup>11</sup>.

Table 2: Dominant soil series descriptions

Wickham series	Fladbury series	Bishampton series
ocm-22cm, dark greyish brown (10YR4/2) <sup>12</sup> very slightly stony silty clay loam with few fine greyish brown (10YR5/2) mottles; medium subangular and tabular chert; moist; moderately developed medium subangular blocky; medium packing density;	ocm-24cm, dark brown (10YR3/3) stoneless clay; moist; moderately developed medium angular blocky; low packing density; moderately weak soil strength; few very fine fibrous roots; non-calcareous; sharp smooth boundary	ocm-13cm, dark brown (7.5YR3/2) stoneless humose sandy clay loam; moist; strongly developed fine subangular blocky; low packing density; moderately weak soil and ped strength; abundant very fine fibrous roots; non-calcareous;

<sup>10</sup> National Soil Resources Institute (NSRI) 2013. *The Soils Guide*. Available: [www.landis.org.uk](http://www.landis.org.uk). Cranfield University, UK. Last accessed 14/08/2013

<sup>11</sup> Munsell Color (2000), *Munsell Color Charts*, Munsell Color, Grand Rapids, MI, USA.

<sup>12</sup> Munsell colour notation describes colour by three attributes: hue (with five principle colours - red (R), yellow (Y), green (G), blue (B), and purple (P) with a preceding intermediate value 2.5-10; value or brightness where zero is black (most dark) and ten is white (most light); and chroma that distinguishes the difference from a pure hue to a gray shade.

<b>Wickham series</b>	<b>Fladbury series</b>	<b>Bishampton series</b>
moderately firm soil strength; many very fine fibrous roots; non-calcareous; clear wavy boundary		abrupt smooth boundary
22cm-45cm, brown (10YR5/3) slightly stony silty clay loam with many fine strong brown (7.5YR5/6) mottles; medium subrounded and tabular chert; very moist; weakly developed; adherent coarse subangular blocky with light brownish grey (2.5Y6/2) faces; medium packing density; moderately firm soil and ped strength; common very fine fibrous roots; non-calcareous; few rounded ferruginous concretions; gradual wavy boundary	24cm-53cm, greyish brown (2.5Y5/2) stoneless clay with very many fine strong brown (7.5YR5/8) mottles; moderately developed coarse prismatic with greyish brown (10YR5/2) faces; medium packing density; moderately firm ped strength; few very fine fibrous roots; non-calcareous; few irregular soft ferri-manganiferous concentrations; abrupt smooth boundary	13cm-38cm, brown to dark brown (7.5YR 4/3) very slightly stony sandy clay loam; small rounded quartzite; slightly moist; moderately developed medium subangular blocky; medium packing density; moderately firm soil strength; moderately weak ped strength; many very fine fibrous roots; non-calcareous; abrupt smooth boundary
45cm-65cm, light grey (5Y7/1) slightly stony silty clay with many fine strong brown (7.5YR5/8) mottles; medium subangular and tabular chert; very moist; weakly developed; adherent medium prismatic; high packing density; moderately firm soil and ped strength; few fine fibrous roots; very slightly calcareous; gradual wavy boundary	53cm-78cm, dark grey (10YR4/1) slightly stony clay with many medium yellowish brown (10YR5/6) mottles; very small subangular sandstone; very moist; moderately developed coarse prismatic with dark greyish brown (10YR4/2) faces; medium packing density; moderately firm soil strength; very few fine fibrous roots; non-calcareous; few rounded ferri-manganiferous nodules; clear smooth boundary	38cm-59cm, brown to dark brown (10YR4/3) slightly stony sandy clay loam; medium rounded quartzite and subrounded sandstone and flint; slightly moist; moderately developed medium subangular blocky; medium packing density; moderately firm soil strength; moderately weak ped strength; many fine fibrous roots; non-calcareous; abrupt smooth boundary
65cm-110cm, light grey to grey (5Y6/1) stoneless silty clay with many fine strong brown (7.5YR5/8) mottles; moist; weakly developed, adherent coarse prismatic; high packing density; very firm soil and ped strength; very slightly calcareous	78cm-94cm, dark greyish brown (10YR4/2), stoneless clay loam with many medium reddish brown (5YR4/4) mottles; very moist; moderately developed medium prismatic with dark grey (10YR4/1) faces; medium packing density; moderately weak soil strength; common very fine fibrous roots; non-calcareous; common rounded soft ferruginous concentrations; abrupt wavy boundary	59cm-85cm, brown to dark brown (7.5YR4/3) slightly stony sandy clay loam with common extremely fine strong brown (7.5YR5/6) and yellowish brown (10YR5/4) mottles; medium rounded quartzite; moist; moderately developed medium angular blocky; medium packing density; moderately firm soil and ped strength; non-calcareous; common clay coats; abrupt smooth boundary

<b>Wickham series</b>	<b>Fladbury series</b>	<b>Bishampton series</b>
	94cm-120cm, light grey to grey (10YR6/1) stoneless clay with many fine strong brown (7.5YR5/6) mottles; wet; weakly developed; adherent medium angular blocky with greyish brown (10YR5/2) faces; medium packing density; moderately firm soil strength; few very fine fibrous roots; non-calcareous	85cm-112cm, brown to dark brown (7.5YR4/4) moderately stony clay with very many coarse yellowish red (5YR4/6) mottles; medium rounded quartzite; moist; weakly developed medium prismatic with brown (7.5YR5/3) faces; high packing density; moderately firm soil and ped strength; few very fine fibrous roots; non-calcareous; common irregular soft ferrimanganiferous concentrations; many clay coats around stones and few filling pores

## 2.3 Soils and land use interactions

### *Agricultural land quality*

- 2.3.1 A review of background ALC information has been undertaken to ascertain the land quality within the study area. The review also sought to identify the extent of existing detailed post-1988 ALC information to ensure that surveys are not repeated unnecessarily.
- 2.3.2 Although there is detailed post-1988 ALC data north of the area it was considered appropriate for a detailed ALC survey to be conducted at Barton Grounds Farm, Newton Purcell. Permission was sought to access additional areas for survey, but was not granted. In areas where permission was not granted the ALC has been assessed from available information.

### *Detailed Agricultural Land Classification survey - Barton Grounds Farm*

- 2.3.3 The land surveyed at Barton Grounds Farm was grassland and the site was bordered by a stream with a large pond situated to the south-east.
- 2.3.4 Soil profiles were examined using an Edelman (Dutch) auger and spade. Approximately one observation is made for each 100m linear run of the route of the Proposed Scheme. At each observation point the following characteristics were assessed for each soil horizon up to a maximum of 120cm or any impenetrable layer:
- soil texture;
  - significant stoniness;
  - colour (including local gley and mottle colours);
  - consistency;
  - structural condition;
  - free carbonate; and
  - depth.

- 2.3.5 Soil wetness was inferred from the matrix colour, presence or absence of - and depth to - greyish and ochreous gley mottling and/or poorly permeable subsoil layers at least 15cm thick.
- 2.3.6 Soil droughtiness was investigated by the calculation of moisture balance equations. Crop-adjusted available profile water is estimated from texture, stoniness and depth and then compared to a calculated moisture deficit for wheat and potatoes. The moisture deficit is a function of potential evapotranspiration and rainfall. Grading of the land can be affected if available water is insufficient to balance moisture deficit and droughtiness occurs. When a profile is found with significant stoniness, sufficient to prevent penetration of a hand auger, then it is assumed for the purposes of calculating droughtiness that similar levels of stoniness continues to the full 1.2m depth considered. The methodology and calculation used to determine the severity of a droughtiness limitation is given in Figure 2.

Figure 2: Methodology for calculating the severity of a droughtiness limitation to Agricultural Land Classification grading<sup>13</sup>

$$AP \text{ wheat (mm)} = \frac{TA_{vt} \times LT_t + \sum (TA_{vs} \times LT_{50}) + \sum (EA_{vs} \times LT_{50-120})}{10}$$

where

$TA_{vt}$  is Total available water ( $TA_v$ ) for the topsoil texture

$TA_{vs}$  is Total available water ( $TA_v$ ) for each subsoil layer

$EA_{vs}$  is Easily available water ( $EA_v$ ) for each subsoil layer

$LT_t$  is thickness (cm) of topsoil layer

$LT_{50}$  is thickness (cm) of each subsoil layer to 50 cm depth

$LT_{50-120}$  is thickness (cm) of each subsoil layer between 50 and 120 cm depth

$\Sigma$  means 'sum of'.

$$AP \text{ potatoes (mm)} = \frac{TA_{vt} \times LT_t + \sum (TA_{vs} \times LT_{70})}{10}$$

where

$LT_{70}$  is thickness (cm) of each subsoil layer to 70 cm depth

**MB (Wheat)** = AP (Wheat) - MD (Wheat)

**MB (Potatoes)** = AP (Potatoes) - MD (Potatoes)

Where

MB is the Moisture Balance

AP is the Crop-adjusted available water capacity

MD is the moisture deficit, as determined by the agro-climatic assessment.

**Table 8 Grade according to droughtiness**

Grade/ Subgrade	Moisture Balance limits (mm)		
	wheat	and	potatoes
1	+30	and	+10
2	+5	and	-10
3a	-20	and	-30
3b	-50	and	-55
4	<-50	or	<-55

<sup>13</sup> Derived from: MAFF, (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

- 2.3.7 Agro-climatic data at Barton Grounds Farm (Table 3) show the site to have moderate rainfall and moderately cool temperatures. Crop moisture deficits are moderate to moderately large. The number of Field Capacity Days (FCD) at Barton Grounds Farm is smaller than the average for lowland England and is therefore considered to be favourable for agricultural land works.

Table 3: Interpolated agro-climatic data for Barton Grounds Farm

<b>Agro-climatic parameter</b>	<b>Barton Grounds Farm</b>
Altitude (AOD)	95m
Average annual rainfall	671mm
Accumulated temperature above 0°C	1,386 day°
Field capacity days	144 days
Average moisture deficit, wheat	102mm
Average moisture deficit, potatoes	92mm

- 2.3.8 The profile found corresponds well with the description of the Fladbury series which is typical of wetter areas.
- 2.3.9 A typical soil profile found during the survey is given in Table 4. The topsoil is of clay or heavy clay loam and reaches an average depth of 27cm. The rest of the soil profile was clayey and displayed evidence of prolonged periods of waterlogging. Most of the soils become slowly permeable at depth and are of WC III and are assessed as Subgrade 3b. In 25% of the profiles examined, no slowly permeable subsoil was found, and these profiles are assessed as being of WC II, resulting in a limitation to Subgrade 3a.

Table 4: Typical soil profile description at Barton Grounds Farm

<b>Barton Grounds Farm</b>
0cm-27cm, very dark grey (10YR3/1) stoneless heavy clay loam; moderate structure; common, coarse, prominent ochreous mottles
27cm-120cm, reddish brown (2.5Y4/3) stoneless to slightly stony clay; poorly structured; common medium distinct ochreous mottles; slowly permeable

### *Desk assessment of Agricultural Land Classification*

- 2.3.10 The study area has also been subject to an intensive desk based assessment which has relied on the interpretation of soil mapping, topography and agro-climatic data, and the interactions between each factor. This resulted in an assessment of the likely soil textures, soil drainage status, landform, gradient, presence of or depth to poorly permeable soil layers and the extent to which crop growth may be limited by soil droughtiness.
- 2.3.11 A professional judgement has then been made of the likely predominant ALC grade for a soil with the characteristics found in the climatic zone of the location within the

route section. The judgement is influenced by the surveyor's experience of previous surveys in the locality and on similar soil types. The resulting grade is that which is considered to be the most likely grade that would be found should a detailed site investigation be conducted, although this does not mean in all cases that that grade will be found in practice.

- 2.3.12 Context land quality was ascertained using information derived from the provisional ALC maps of England and Wales produced by MAFF in the 1960s and 1970s. These maps were originally published at a scale of 1:63,360 and are available at a scale of 1:250,000 in paper and digital formats. These maps were published at strategic scales only and based on a methodology that has since been revised twice and cannot be used definitively to classify individual sites and analysis of other information sources is therefore necessary. They show the section to be provisionally mapped as predominantly Grade 4, with pockets of Grade 3 and Grade 2 to the north-west.
- 2.3.13 Detailed post-1988 ALC data is also available at three sites north of the study area. To the north of Newton Purcell is a parcel of land of around 42 hectares classified as Grades 1 to 3b (with the majority in Grade 2) and lies to the immediate east of the disused Great Central Railway (GCR). To the west of Newton Purcell are approximately 85 hectares of Grade 2 land, adjacent to a parcel of around eighteen hectares classified as Grades 2 to 3b. The third site at Barton Grounds Farm was surveyed in 2012 and found to be predominantly of Subgrade 3b quality, with approximately 25% in Subgrade 3a.

### **Agro-climatic limitations**

- 2.3.14 The local agro-climatic data have been interpolated from the Meteorological Office's standard 5km grid point data set for three representative locations within the Calvert, Twyford and Chetwode area and set out in Table 5. The data show the area to be moderately cool, with an average accumulated temperature of around 1,400 day°C and moderate rainfall of 660mm per year. The average number of FCD is approximately 143 which is lower than the average for lowland England (150 days) and is considered to be favourable for providing opportunities for agricultural land working.

Table 5: Interpolated agro-climatic data

Climatic parameter	Calvert	Twyford	Chetwode
Altitude (AOD)	90	90	100m
Average annual rainfall	644mm	659mm	670mm
Accumulated temperature above 0°C	1,404 day°	1,404 day°	1,386 day°
Field capacity days	144 days	140 days	144 days
Average moisture deficit, wheat	100mm	105mm	102mm
Average moisture deficit, potatoes	92mm	95mm	92mm

### **Site limitations**

- 2.3.15 The assessment of site factors is primarily concerned with the way in which topography influences the use of agricultural machinery and hence the cropping

potential of land. Gradient and microrelief, with complex changes of slope angle or direction over short distances, are not considered limiting in this section of the Proposed Scheme.

- 2.3.16 Flooding is limited to the floodplains of the Padbury Brook which is present across much of the study area and is a potential limitation to agricultural land quality. Subject to season, duration and frequency flooding could downgrade agricultural land to Subgrade 3b or Grade 4.

### *Soil limitations*

- 2.3.17 The main soil properties which affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. Together they influence the functions of soil and affect the water availability for crops, drainage, workability and trafficability. There are three distinct soil characteristics within the study area:
- the slowly permeable, seasonally wet loamy and clayey soils;
  - loamy and clayey soils with slightly impeded drainage; and
  - floodplain soils affected by high ground water.

### *Interactive limitations*

- 2.3.18 The physical limitations which result from interactions between climate, site and soil are soil wetness, droughtiness and susceptibility to erosion. Each soil is allocated a WC based on soil structure, evidence of waterlogging and the number of FCD; the topsoil texture then determines its ALC Grade in accordance with Table 6 of the MAFF ALC guidelines (shown in Figure 3). It is not considered likely that droughtiness will represent a limiting factor to the land quality within this section.

Figure 3: Agricultural Land Classification grade according to soil wetness<sup>14</sup>

Wetness Class	Texture <sup>1</sup> of the top 25 cm	Field Capacity Days			
		<126	126-150	151-175	176-225
I	S <sup>2</sup> LS <sup>3</sup> SL SZL	1	1	1	2
	ZL MZCL MCL SCL	1	1	1	3a
	HZCL HCL	2	2	2	3b
	SC ZC C	3a(2)	3a(2)	3a	3b
II	S <sup>2</sup> LS <sup>3</sup> SL SZL	1	1	1	3a
	ZL MZCL MCL SCL	2	2	2	3b
	HZCL HCL	3a(2)	3a(2)	3a	3b
	SC ZC C	3a(2)	3b(3a)	3b	3b
III	S <sup>2</sup> LS SL SZL	2	2	2	3b
	ZL MZCL MCL SCL	3a(2)	3a(2)	3a	3b
	HZCL HCL	3b(3a)	3b(3a)	3b	4
	SC ZC C	3b(3a)	3b(3a)	3b	4
IV	S <sup>2</sup> LS SL SZL	3a	3a	3a	3b
	ZL MZCL MCL SCL	3b	3b	3b	3b
	HZCL HCL	3b	3b	3b	4
	SC ZC C	3b	3b	3b	5
V	S LS SL SZL	4	4	4	4
	ZL MZCL MCL SCL	4	4	4	4
	HZCL HCL	4	4	4	4
	SC ZC C	4	4	4	5
Soils in Wetness Class VI - Grade 5					

<sup>1</sup>For naturally calcareous soils with more than 1% CaCO<sub>3</sub> and between 18% and 50% clay in the top 25 cm. the grade, where different from that of other soils, is shown in brackets

<sup>2</sup> Sand is not eligible for Grades 1, 2 or 3a

<sup>3</sup> Loamy sand is not eligible for Grade 1

Where S = sand, Z = silt, C = clay, L = loamy and P = peat.

For sand the coarseness of the grain is sub-divided into coarse (c), medium (m) and fine (f). The subdivisions of clay loam and silty clay loam classes are indicated as medium (M) (less than 27% clay); heavy (H) (27-35% clay).

The average number of FCD in the Calvert, Twyford and Chetwode area is 143, and shown in the highlighted column.

<sup>14</sup> Derived from: MAFF (1988), Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land.

- 2.3.19 The slowly permeable, seasonally wet clay loam, clay and fine loamy over clayey soils of the Denchworth, Ashley and Bishampton associations are typically non-calcareous, of WC III or IV. These soils are assessed as Subgrade 3b under the applicable climatic conditions.
- 2.3.20 The better draining Beccles 3 and Evesham 2 soils associated with slopes and hill tops are typically of WC II or III. Evesham 2 soils are fine loamy or fine silty over clayey throughout and are assessed as Subgrade 3b, regardless of the better drainage. Beccles 3 soils are generally sandy clay loam or clay loam over clay and the majority of the soils in this section are assessed as Subgrade 3b.
- 2.3.21 The wet alluvial soils of Fladbury 1 and the fine loamy over clay and clayey Wickham 2 associations are characteristically of WC IV and limited to Subgrade 3b.
- 2.3.22 Overall, the majority of the soils within this section of the Proposed Scheme are of Subgrade 3b quality, with a moderate proportion of Subgrade 3a.

## 3 Forestry

- 3.1.1 Assessment of forestry resources has primarily had regard to the National Forest Inventory<sup>15</sup>. The area of land under forestry (i.e. trees and woodland) within 2km either side of the route centre line has been derived using a Geographic Information System (GIS), and is shown in Table 6.
- 3.1.2 Woodland cover in the study area is generally low, except to the south which contains the well-wooded Calvert Jubilee Nature Reserve and Decoypond Wood, and to the north around Chetwode where there are a number of small woodlands including Manthorn Farm Wood and Church Copse.

Table 6: Area of woodland within the study area and construction boundary

	<b>Area of forestry land (ha)</b>	<b>Forestry land as a % of total land area</b>
Forestry land in 4km-wide study area	175.8	5% (forestry land use within 4km-wide study area)
Forestry land within construction boundary	17.3	Approximately 4% of the land required for the construction of the Proposed Scheme is presently wooded

<sup>15</sup> Forestry Commission (2001), *National Forest Inventory Woodland and Ancient Woodland* (as updated).

## 4 Assessment of effects on holdings

- 4.1.1 The effects on holdings have been assessed through a series of interviews with farmers along the proposed route carried out between May 2012 and June 2013, according to the methodology set out in the Scope and Methodology Report (within Volume 5: Appendix CT-001-000/1) and the Addendum (Appendix CT-001-000/2). Where interviews have not been possible the data has been estimated, as described in the Scope and Methodology Addendum (Appendix CT-001-000/2).
- 4.1.2 The nature of impacts considered comprises the temporary and permanent land required from the holding, the temporary and permanent severance of land, the permanent loss of key farm infrastructure and the imposition of disruptive effects (particularly noise and dust) on land uses and the holding's operations. These impacts occur primarily during the construction phase of the Proposed Scheme and are set out in Table 7:

Table 7: Summary of assessment of effect on holdings

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA13/1 *	Land required: 77.8ha (6%). Low impact  Severance: no access provided to small area of land severed near the Steeple Claydon infrastructure maintenance depot (IMD). Impact downgraded due to small size of parcel to low impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft Code of Construction Practice <sup>16</sup> (CoCP). Negligible impact	Land required: 53.3ha (4%). Negligible impact  Severance: no access provided to small area of land severed near the IMD. Impact downgraded due to small size of parcel to low impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall assessment: minor effect	Overall assessment: minor effect
CFA13/2	Land required: 143.3ha (25%). High impact  Severance: land severed to the east of the Proposed Scheme but accessible along existing highway, as at present. A small parcel north of Twyford may be inaccessible whilst the viaduct is constructed. Medium impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 77.4ha (14%). Medium impact  Severance: access to land severed to the east available via West Street bridge. Medium impact  Infrastructure: buildings and residential property demolished at Shepherd's Furze Farm and a building at Portway Farm also taken. High impact
	Overall temporary assessment: major effect due to proportion of farm removed,	Overall permanent assessment: major effect due to residential and building demolition,

<sup>16</sup> Volume 5: Appendix CT-003-000

<b>Holding reference, name and description</b>	<b>Construction effects</b>	<b>Residual effects post restoration of land required temporarily</b>
	severance and high sensitivity of holding.	land loss and severance
CFA13/3  Elm Tree/ Stone Court Farm  400ha arable  Medium sensitivity to change	Land required: 58.8ha (15%). Medium impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 19.8ha (5%). Low impact.  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to the proportion of the holding required	Overall permanent assessment: minor effect
CFA13/4  Lake Farm  81ha arable, beef cattle and sheep  Medium sensitivity to change	Land required: 9.8ha (12%). Medium impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.5ha (1%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to the proportion of the holding required	Overall permanent assessment: Negligible impact
CFA13/5  Home Farm  33.3ha beef cattle  Medium sensitivity to change	Land required: 11.8ha (35%). High impact  Severance: subject to timing there may not be access provided during construction of the Twyford viaduct to land to north of the Proposed Scheme. High impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 4.4ha (13%). Medium impact  Severance: access will be provided to land severed to the east of the Proposed Scheme via new dedicated access from sewerage works. Medium impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of farm removed and severance	Overall permanent assessment: moderate effect due to proportion of farm removed and severance
CFA13/6  Cowley Lodge Farm  440ha arable and sheep  Medium sensitivity to change	Land required: 3.5ha (< 1%). Negligible impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 1.7ha (< 1%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: Negligible effect	Overall permanent assessment: negligible effect

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA13/7  Charndon Grounds Farm  33ha grazing  Medium sensitivity to change	Land required: 2.5ha (8%). Low impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.2ha (1%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: minor effect	Overall permanent assessment: negligible effect
CFA13/8  Cowley Farm  170ha arable and sheep  Medium sensitivity to change	Land required: 20.7ha (12%). Medium impact  Severance: small parcel (4.5ha) severed west of the Proposed Scheme - structure provided. Low impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 16.2ha (9%). Low impact  Severance: small parcel (4.5ha) severed below the Proposed Scheme - structure provided. Low impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to proportion of holding removed	Overall permanent assessment: minor effect
CFA13/9  Casemore Farm  113ha arable and sheep  Medium sensitivity to change	Land required: 7.4ha (7%). Low impact  Severance: very small parcel (1.0ha) west of the Proposed Scheme may not be accessible during construction but downgraded due to small size to low impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 5.0ha (4%). Negligible impact  Severance: access to severed land via viaduct. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: minor effect	Overall permanent assessment: negligible effect
CFA13/10  Grange Farm  374ha arable  Medium sensitivity to change	Land required: 1.1ha (< 1%). Negligible impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.8ha (< 1%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: negligible effect	Overall permanent assessment: negligible effect
CFA13/11  Moat Farm  226ha arable	Land required: 44.2ha (20%). High impact  Severance: land severed to the east of the Proposed Scheme available under viaduct and a replaced crossing close to Manthorn Farm and use of the public highway. Medium	Land required: 21.6ha (10%). Medium impact  Severance: land severed to the east of the Proposed Scheme available under viaduct and a replaced existing crossing close to Manthorn Farm and highway. Medium

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
Medium sensitivity to change	impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed and severance	Overall permanent assessment: moderate effect due to proportion of holding removed and severance
CFA13/12  Chetwode Manor  436.5ha arable	Land required: 37.1ha (8%). Low impact  Severance: land to the west of the Proposed Scheme near Manthorn Farm severed but accommodation structure provided. Land take increased with acquisition of small (1.1ha) severed parcel to the west of the Proposed Scheme near Newton Purcell. Low impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 22.2ha (5%). Low impact (plus 1.1ha severed)  Severance: land to the west of the Proposed Scheme near Manthorn Farm severed but accommodation structure provided. Permanent land take increased with acquisition of small (1.1ha) severed parcel to the west of the Proposed Scheme near Newton Purcell. Low impact  Infrastructure: property demolition. Impact reduced as farm buildings to be demolished are redundant for agriculture, but are understood to have planning permission for residential conversion. Medium impact
Medium sensitivity to change	Overall temporary assessment: minor effect	Overall permanent assessment: moderate effect due to property demolition
CFA13/13  Barton Hill Farm  54.9ha arable. Grass let for grazing	Land required: 15.3ha (28%). High impact  Severance: no new severance. Farm severed by the disused GCR with no effective crossing other than public highway; this will remain. Negligible impact	Land required: 7.2ha (13%). Medium impact  Severance: no new severance. Farm severed by disused GCR with no effective crossing other than public highway; this will remain. Negligible impact
Medium sensitivity to change	Disruptive effects: although farm campsite may suffer adversely from construction noise activities there will be no impact on agricultural activity as construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Impact on camping assessed as medium impact	Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed and disruption to diversified camping activity	Overall permanent assessment: moderate effect due to proportion of holding removed
CFA13/14  Barton Grounds Farm  26.3ha beef cattle	Land required: 15ha (57%). High impact  Severance: none. Land take increased with acquisition of small (1.6ha) severed parcel to the east of the Proposed Scheme. Negligible impact	Land required: 6.6ha (25%). High impact (plus 1.6ha severed)  Severance: none. Land take increased with acquisition of small (1.6ha) severed parcel to the east of the Proposed Scheme. Negligible impact
Medium sensitivity to change	Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set	Infrastructure: no buildings or other farm

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
	out within the draft CoCP. Negligible impact	infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed	Overall permanent assessment: major/moderate effect due to proportion of holding removed
CFA13/15 *	Land required: 1.6ha (10%). Medium impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.7ha (6%). Low impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to proportion of holding removed	Overall permanent assessment: minor effect.
CFA13/16 *	Land required: 0.4ha (10%). Medium impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.1ha (2%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: minor effect	Overall permanent assessment: negligible effect
CFA13/17	Land required: 0.3ha (5%). Low impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.2ha (5%). Low impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: negligible effect	Overall permanent assessment: Negligible effect
CFA13/18 *	Land required: 2.9ha (32%). High impact  Severance: provided a new field gateway is provided from the realigned highway there will be no severance. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 1.6ha (18%). Medium impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed	Overall permanent assessment: moderate effect due to proportion of holding removed

<b>Holding reference, name and description</b>	<b>Construction effects</b>	<b>Residual effects post restoration of land required temporarily</b>
CFA13/19 *  Three Bridge Mill  5.2ha grazing  Low sensitivity to change	Land required: 1.6ha (31%). High impact  Severance: land is severed during construction of flood compensation area but land should be equally accessible as at present. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0ha (0%). Negligible impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to proportion of holding removed	Overall permanent assessment: negligible effect
CFA13/20*  New Manor Farm  26.0ha arable and grazing  Medium sensitivity to change	Land required: 4.1ha (16%). Medium impact  Severance: none. Negligible impact  Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 1.4ha (6%). Low impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to proportion of holding removed	Overall permanent assessment: minor effect
CFA13/21 *  Un-named paddock 2  1.5ha outdoor pigs  Medium sensitivity to change	Land required: 1.4ha (95%). High impact  Severance: none. Negligible impact  Disruptive effects: no impact on continued agricultural activity as holding taken at start of construction. Dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 1.3ha (88%). High impact  Severance: none. Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed	Overall permanent assessment: major/moderate effect due to proportion of holding removed
CFA13/22 *  Un-named arable  22.1ha arable  Medium sensitivity to change	Land required: 13.9ha (63%). High impact  Severance: none. Negligible impact  no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.7ha (3%). Negligible impact  Severance: Negligible impact  Infrastructure: no buildings or other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of holding removed	Overall permanent assessment: negligible impact

\* No farm impact assessment interview conducted; data estimated

## 5 References

British Geological Survey. <http://bgs.ac.uk/geologyofbritain/home/html>; Accessed on 18 March 2013

Cranfield University (2001), *The National Soil Map of England and Wales* 1:250,000 scale.

Department for Environment, Food and Rural Affairs (Defra) (2005), *Likelihood of Best and Most Versatile Agricultural Land* (1:250,000).

Forestry Commission (2001), *National Forest Inventory Woodland and Ancient Woodland* (as updated).

Meteorological Office. (1989), *Gridpoint Meteorological data for Agricultural Land Classification of England and Wales and other Climatological Investigations*.

Ministry of Agriculture, Fisheries and Food (1983), *Agricultural Land Classification of England and Wales* (1:250,000).

MAFF (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

Munsell Color (2000), *Munsell color charts*, Munsell Color, Grand Rapids, MI, USA.

Soil Survey of England and Wales (1984), *Soils and Their Use in South East England*.

National Soil Resources Institute (NSRI) 2013. *The Soils Guide*. Available: [www.landis.org.uk](http://www.landis.org.uk). Cranfield University, UK. Last accessed 14/08/2013